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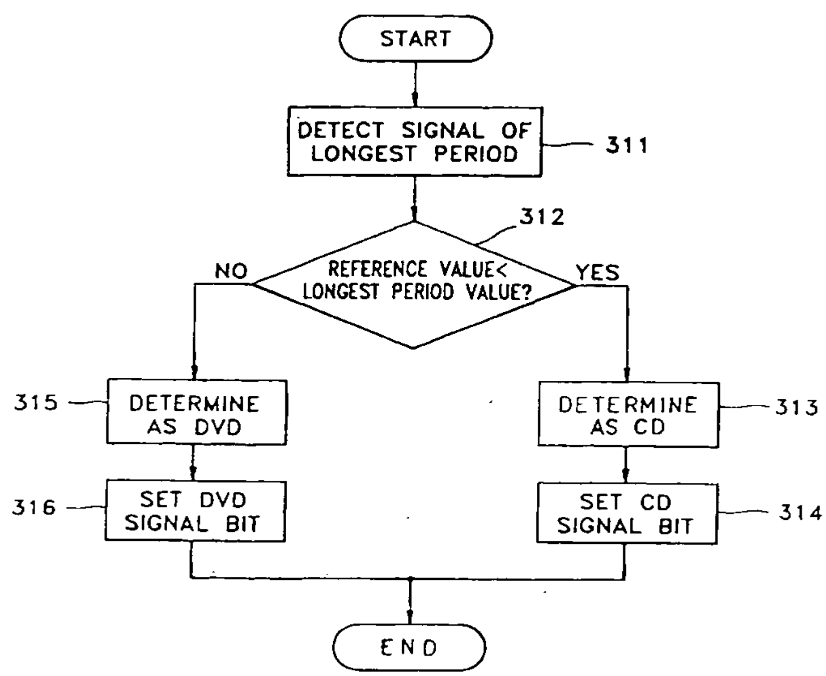
(54) Automatic disk discrimination method and apparatus in optical disk system

(57) Automatic disk discriminating method and apparatus in an optical disk system are disclosed. A specific period value (that is, a specific frequency) of the information signal reproduced from a disk is compared with a predetermined reference value. If a higher frequency than the predetermined reference value is detected, the disk is determined to be a DVD. If a lower frequency than the predetermined reference value is detected, the disk is determined to be a CD. The disk discriminating method and apparatus are less affected by noise, thereby improving the accuracy in determining the disk type.

FIG. 3



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Description

The present invention relates to an automatic disk discriminating method and apparatus in an optical disk system, and more particularly, to an automatic disk discriminating method and apparatus for discriminating between disk types by comparing a specific period value of a radio frequency (RF) signal reproduced from each disk with a predetermined reference value, after focus controlling.

Generally, in an optical disk system, when data stored in a disk are read, the focus spot of a laser beam radiated from an optical pickup should land on an exact spot of a disk and travel exactly along a guard groove or data pit so that precise and distortion-free signals are read. In a system of reproducing optical disks having the same physical structure, that is, the same substrate thickness, a reproduction method can be determined by reading out data in a lead-in region of the disk without discriminating between disk types.

However, in the case of a system which can reproduce disks having different physical structures such as a compact disk (CD) or a digital video disk (DVD), a stable servo operation is difficult to achieve and thus the disk types cannot be discriminated. If the disk types are not discriminated, further operations cannot be performed.

Figure 1 shows an optical disk system adopting a conventional disk discriminating apparatus utilizing the amplitude of an information signal to overcome the problem. The disk types can be discriminated by two methods in the disk discriminating apparatus shown in Figure 1.

As the first disk discriminating method, after performing focusing and tracking control operations corresponding to the CD by a focus driver 116 and a track driver 117, an information signal is detected by a photodiode 112b and a current-to-voltage converter 112c. Subsequently, the amplitude of the information signal is detected by an information signal amplitude detector 113 and compared with a predetermined value by a comparator 114. Based on the compared result, the CPU determines the switching position of the switch 121. Specifically, if the amplitude of the information signal is less than the predetermined value, the comparator outputs a signal (DVD) which signifies that the disk is a DVD. Then, the CPU 120 controls the switching position of the switch 121 such that a DVD loop in the servo signal processor 115 is active, and generates and outputs servo control signals for the DVD. Meanwhile, if the amplitude of the information signal is larger than the predetermined value, the comparator outputs a signal (CD) which signifies that the disk is a CD. Then, the CPU 120 maintains the switching position of the switch 121 such that a CD loop in the servo signal processor 115 is active, and generates and outputs servo control signals for the CD.

On the other hand, as the second method, information for discriminating the thickness of a substrate is extracted by performing focusing and tracking control operations corresponding to the CD. If a central processing unit (CPU) 120 recognizes that the thickness of substrate corresponds to the DVD by use of the information, the apparatus is switched to a focusing control state for the DVD by the switch 121. In Figure 1, the reference numerals 118, 119 and 123 indicate a voice coil motor (VCM) driver, a spindle driver and a spindle motor, respectively.

However, according to these methods, the disk type may be erroneously determined if there is noise in the information signal to change the amplitude of the information signal.

With a view to the solving or reducing the abovedescribed problems, it is an aim of embodiments of the present invention to provide an automatic disk discriminating method in an optical disk system for discriminating between disk types by comparing a specific period value (that is, a specific frequency) of a radio frequency (RF) signal reproduced from a disk with a predetermined reference value, after focus controlling.

It is another aim of embodiments of the present invention to provide an apparatus suitable for implementing the disk discriminating method in an optical disk system.

According to a first aspect of the invention, there is provided an automatic disk discriminating method in an optical disk system which can compatibly reproduce optical disks of different types, said method comprising the steps of: detecting a specific period value of an information signal reproduced from an optical disk when the light from an objective lens is focused on the recording plane of said optical disk; and discriminating a disk type by comparing the detected specific period value with a predetermined reference value.

Preferably, said optical disk system can compatibly reproduce a compact disk and a digital video disk.

The specific period value is preferably the longest period value of the information signal.

Preferably, the reference value is set as an intermediate value of the respective longest periods of the information signal reproduced from said compact disk and said digital video disk.

The specific period value may be the shortest period value of the information signal.

The reference value is preferably set as an intermediate value of the respective shortest periods of the information signal reproduced from said compact disk and said digital video disk.

According to a second aspect of the invention, there is provided an automatic disk discriminating apparatus in an optical disk system which can compatibly reproduce optical disks of different disk types, said apparatus comprising: a digital signal processor for detecting a specific period value of an information signal reproduced from an optical disk when the light from an objective lens is focused on the recording plane of said optical

disk and discriminating a disk type by comparing the detected specific period value with a predetermined reference value.

Preferably, said optical disk system can compatibly reproduce a compact disk and a digital video disk.

The specific period value may be the longest period value of the information signal.

The reference value is preferably set as an intermediate value of the respective longest periods of the information signal reproduced from said compact disk and said digital video disk.

The specific period value may be the shortest period value of the information signal.

The reference value may be set as an intermediate value of the respective shortest periods of the information signal reproduced from said compact disk and said digital video disk.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a block diagram of an optical disk system adopting a conventional disk discriminating apparatus;

Figure 2 is a block diagram of an optical disk system adopting an automatic disk discriminating apparatus according to an aspect of the present invention; and

Figure 3 is a flowchart for explaining an automatic disk discriminating method according to an embodiment of the present invention in an optical disk system.

The optical disk system shown in Figure 2 includes an optical disk 211, an optical pickup 212, a laser diode 212a, a photo diode 212b, a current-to-voltage converter 212c, an equalizer & PLL (phase-locked loop) 213, a digital signal processor (DSP) 214, a servo signal processor 215, a focus driver 216, a track driver 217, a voice coil motor (VCM) driver 218, a spindle driver 219, a CPU 220, a front display 221, a decoder 222, a switch 223 and a spindle motor 224.

Here, the optical pickup 212 can reproduce both CD and DVD. The focus driver 216 and track driver 217 are for moving the optical pickup 212. The spindle driver 219 is for rotating the optical disk 211. When compared with the disk discriminating apparatus shown in Figure 1, the information signal amplitude detector 113 and comparator 114 are replaced with the equalizer & PLL 213 and DSP 214, respectively, and the front display 221 and decoder 222 are further included.

Figure 3 is a flowchart for explaining an automatic disk discriminating method, which is executed in the DSP 214 shown in Figure 2.

The disk discriminating method illustrated in Figure 3 includes the steps of performing a focus control operation corresponding to an arbitrary substrate thickness with respect to the optical disk rotating at a predetermined speed and detecting a specific period value of an information signal reproduced from the optical disk (step 311), and determining the substrate thickness of the optical disk, that is, the disk type, by comparing the detected specific period value with a predetermined reference value (steps 312 through 316).

The operation and effect of the arrangement will now be described, based on the aforementioned configuration.

In embodiments of the present invention, the differences in the physical structure of optical disks are used.

Generally, pits which store the information signals on the CD and DVD are different from each other in their shortest pit lengths (3T) and longest pit lengths (11T for the CD and 14T for the DVD). Here, T means the period of main clock used in recording a signal on a disk. Since the period T for CD is longer than that for the DVD, the pit on the CD is longer than that on the DVD. Thus, the lengths of the pits are different depending on the disk type. This means that frequencies of an information signal (RF signal) which are reproduced from the disks are different depending on the disk type when the disks rotate at the same velocity.

Referring to Figure 2, an optical disk 211 is rotated at a constant angular velocity by the spindle driver 219 and a laser beam is focused on the optical disk 211. Then, the information signal stored on the disk 211 is read out. The information signal includes various periods. Among them, specific period values such as the longest or shortest period values are used to determine the disk type. For the sake of convenience, the longest period value is taken in this embodiment.

First, a preliminary determination may be performed to enhance the reliability of the discrimination process. To carry out the preliminary determination, optical disk 211 is seated on a turntable, and is rotated at a constant angular velocity of 8.48Hz by the spindle motor 224. Then, a laser beam emitted through an objective lens is positioned 23.5mm from the center of the optical disk 211.

At this time, the switch 223 is positioned such that a CD loop of two loops in the servo signal generator 215 is selected assuming that the optical disk is a CD. Thus, servo control signals which are generated by the CD loop to drive the CD are supplied to the focus driver 216 and the track driver 217.

Subsequently, the objective lens is moved up and down such that the light passing through the objective lens is focused on the disk face. Then, the amplitude of a focus error signal is detected and compared with a predetermined threshold. If the amplitude of a focus error is smaller than the predetermined threshold, the optical disk is determined to be a CD. On the other hand, if the amplitude of a focus error signal is larger than the predetermined threshold, the optical disk is determined

to be a DVD.

The detection of the focus error signal and the comparison of such signal with the predetermined value is performed twice. If the disk type is not determined by two trials, a third test is performed to determine the disk type in which the disk type indicated twice out of the three tests is determined as the correct disk type. Afterwards, servo control signals are generated according to the result of the preliminary tests.

Then, the main determination which uses the longest period value of the RF signal is carried out.

Specifically, the digital signal processor 214 detects the longest period value of the RF signal, i.e., the information signal, incoming through the equalizer & PLL 213.

In the case of the CD, the longest pit length (S) is 3.1815μm which corresponds to 11T. If the CD rotates at a frequency of 8.48Hz, the linear velocity (v) will be 1.2525m/s. Then, the longest period t(llT) can be expressed by the following equation (1):

$$t(11T) = \frac{S}{v} = \frac{3.1818\,[\mu m]}{1.2525\,[m/s]} = 2.5454\,[\mu s] \qquad (1)$$

Also, in the case of the DVD, the longest pit length (S) is 1.866μm which corresponds to 14T. If the DVD rotates at the same frequency as that of the CD, i.e., 8.48Hz, the linear velocity (v) is 1.2525m/s. Then, the longest period t(14T) can be expressed by the following equation (2):

$$t(14T) = \frac{S}{v} = \frac{1.866\,[\mu m]}{1.2525\,[m/s]} = 1.49\,[\mu s] \qquad (2)$$

The operation of the digital signal processor 214 will now be described in more detail with reference to Figure 3.

In the step 311, the longest period value among periods of the RF signal incoming through the equalizer & PLL 213 is detected. In the step 312, the detected longest period value is compared with a predetermined reference value. The reference value is set as an intermediate value of the longest periods of the information signal reproduced from the CD and DVD, respectively.

If the longest period value is greater than the reference value as the result of comparison in the step 312, the optical disk seated on the turntable is determined to be a CD in the step 313. Subsequently, a CD/DVD discriminating bit applied to the CPU 220 is set to indicate that the disk being reproduced is a CD in the step 314.

If the longest period value is less than the reference value as the result of comparison in the step 312, the optical disk seated on the turntable is determined to be a DVD in the step 315. Subsequently, the CD/DVD discriminating bit applied to the CPU 220 is set to indicate that the disk being reproduced is a DVD in the step 316.

Afterwards, the CPU 220 outputs a switching signal to the servo signal processor 215, decoder 222 and front display 221 so that a servo gain control is carried out according to the disk type.

In another embodiment of the present invention, the disk type is determined by detecting the shortest period value of the RF signal (information signal) detected from the equalizer & PLL 213. At this time, an intermediate value of the respective shortest period values of the information signal reproduced from the CD and the DVD is used as a predetermined reference value.

As described above, in an automatic disk discriminating method and apparatus in an optical disk system according to the present invention, the longest period (that is, the lowest frequency) or the shortest period (that is, the highest frequency) of the signal reproduced from each disk having different thicknesses is compared with a predetermined reference value, respectively. If a higher frequency than the predetermined reference value is detected, the disk is determined to be a DVD. If a lower frequency than the predetermined reference value is detected, the disk is determined to be a CD. Therefore, compared to the conventional method for discriminating between disk types using the amplitude of an information signal, embodiments of the present invention are less affected by noise, thereby improving the accuracy in determining the disk type.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An automatic disk discriminating method in an optical disk system which can compatibly reproduce optical disks of different types, said method com-

prising the steps of:

detecting (311) a specific period value of an information signal reproduced from an optical disk (211) when the light from an objective lens (212) is focused on the recording plane of said optical disk (211); and

discriminating a disk type by comparing (312) the detected specific period value with a predetermined reference value.

2. An automatic disk discriminating method in an optical disk system as claimed in claim 1, wherein said optical disk system can compatibly reproduce a compact disk and a digital video disk.

3. An automatic disk discriminating method in an optical disk system as claimed in claim 2, wherein the specific period value is the longest period value of the information signal.

4. An automatic disk discriminating method in an optical disk system as claimed in claim 3, wherein the reference value is set as an intermediate value of the respective longest periods of the information signal reproduced from said compact disk and said digital video disk.

5. An automatic disk discriminating method in an optical disk system as claimed in claim 2, wherein the specific period value is the shortest period value of the information signal.

6. An automatic disk discriminating method in an optical disk system as claimed in claim 5, wherein the reference value is set as an intermediate value of the respective shortest periods of the information signal reproduced from said compact disk and said digital video disk.

7. An automatic disk discriminating apparatus in an optical disk system which can compatibly reproduce optical disks of different disk types, said apparatus comprising:

a digital signal processor (214) for detecting a specific period value of an information signal reproduced from an optical disk (211) when the light from an objective lens (212) is focused on the recording plane of said optical disk (211) and discriminating a disk type by comparing the detected specific period value with a predetermined reference value.

8. An automatic disk discriminating apparatus in an optical disk system as claimed in claim 7, wherein said optical disk system can compatibly reproduce a compact disk and a digital video disk.

9. An automatic disk discriminating apparatus in an optical disk system as claimed in claim 7 or 8, wherein the specific period value is the longest period value of the information signal.

10. An automatic disk discriminating apparatus in an optical disk system as claimed in claim 9, wherein the reference value is set as an intermediate value of the respective longest periods of the information signal reproduced from said compact disk and said digital video disk.

11. An automatic disk discriminating apparatus in an optical disk system as claimed in claim 8, wherein the specific period value is the shortest period value of the information signal.

12. An automatic disk discriminating apparatus in an optical disk system as claimed in claim 11, wherein the reference value is set as an intermediate value of the respective shortest periods of the information signal reproduced from said compact disk and said digital video disk.

FIG. 1 (PRIOR ART)

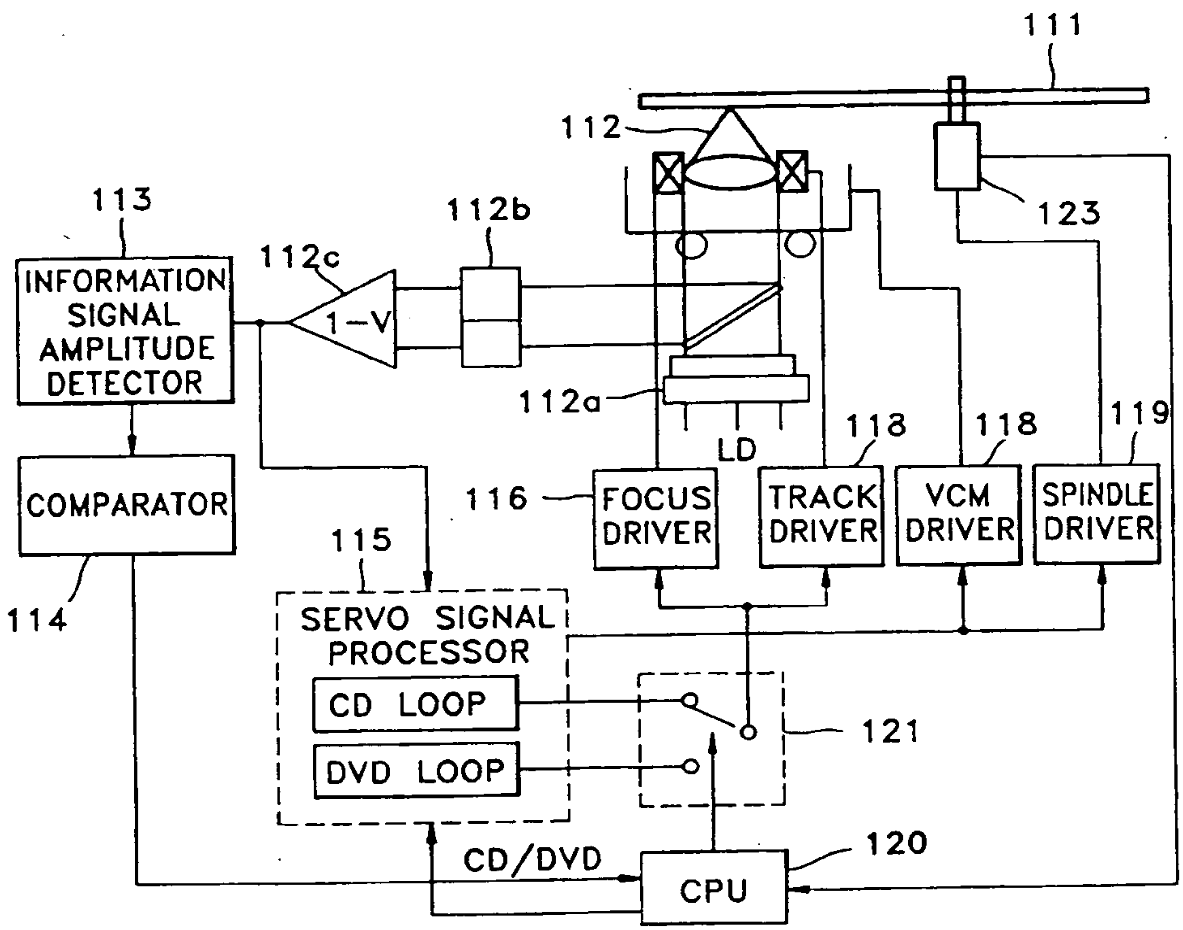


FIG. 2

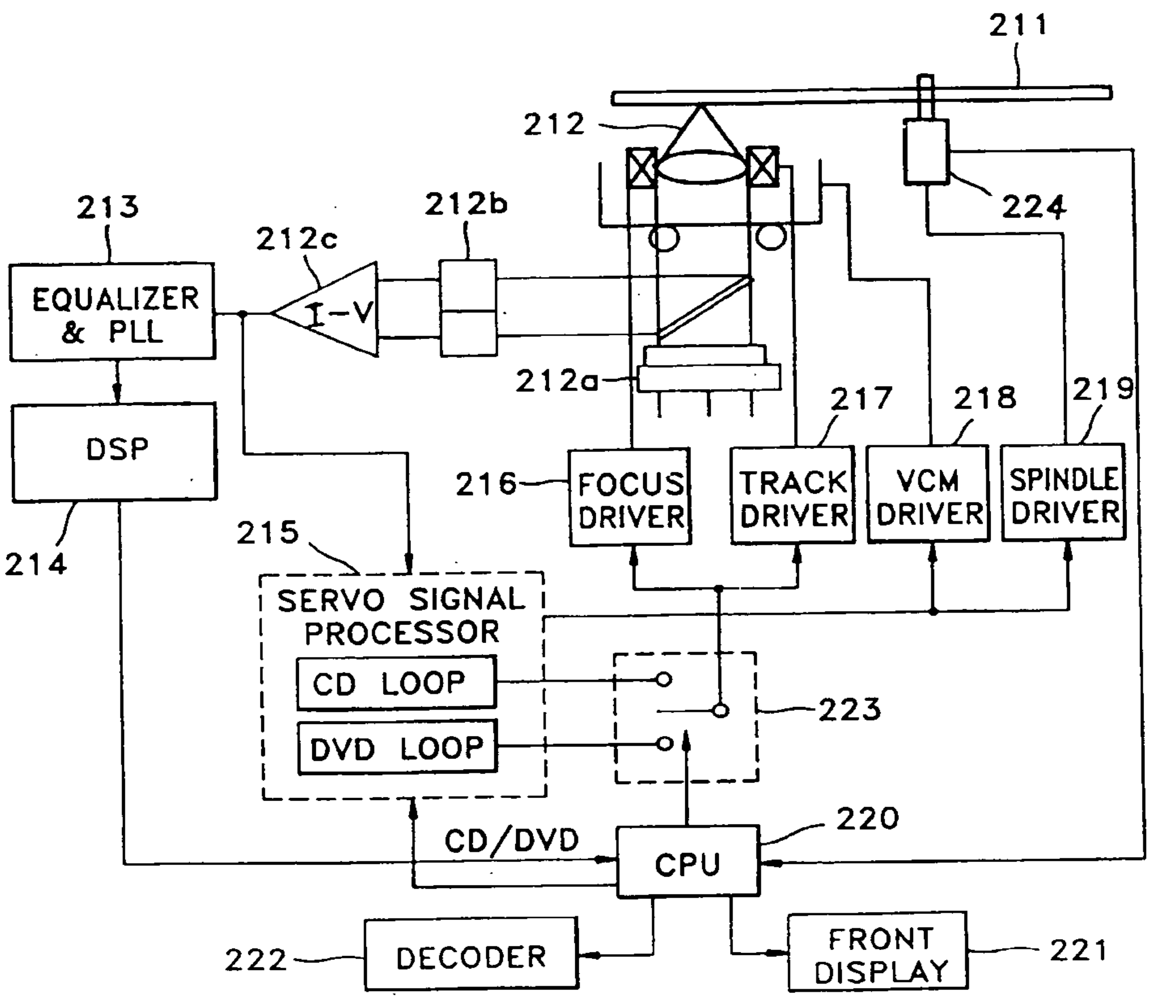
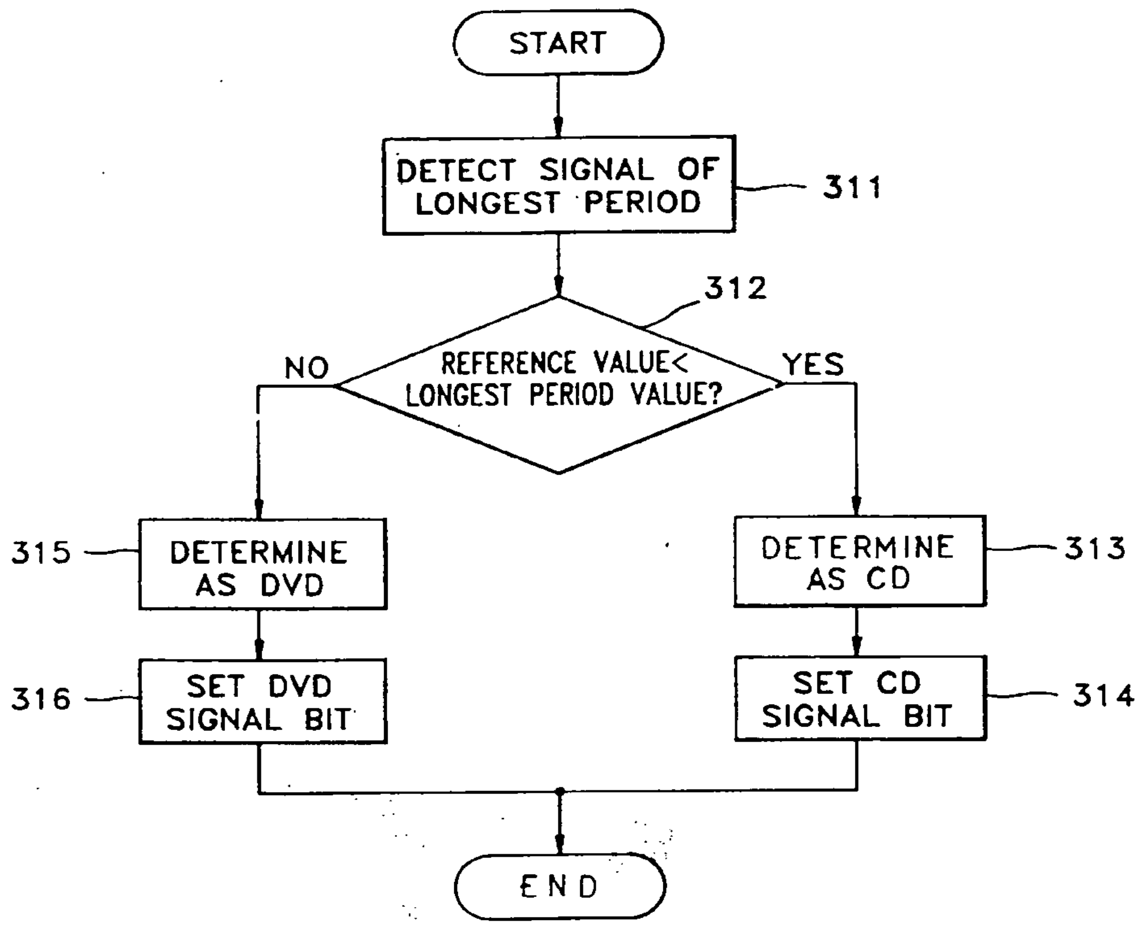

211
212
213
212b
212c
224
EQUALIZER & PLL
I-V
212a
217
218
219
DSP
216
FOCUS DRIVER
TRACK DRIVER
VCM DRIVER
SPINDLE DRIVER
214
215
SERVO SIGNAL PROCESSOR
CD LOOP
DVD LOOP
223
220
CD/DVD
CPU
222
DECODER
FRONT DISPLAY
221

FIG. 3


START
DETECT SIGNAL OF LONGEST PERIOD
311
312
REFERENCE VALUE< LONGEST PERIOD VALUE?
NO
YES
315
DETERMINE AS DVD
DETERMINE AS CD
313
316
SET DVD SIGNAL BIT
SET CD SIGNAL BIT
314
END